

DAVID ANTHONY VALLADO

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EDUCATION

Master of Science in Astronautical Engineering, Air Force Institute of Technology, 1984

Master of Science in Systems Management, University of Southern California, 1982

Bachelor of Science in Astronautical Engineering, United States Air Force Academy, 1980

CAREER SUMMARY

Over 40 years in education, research, acquisition and development, and operations with specific expertise in technical and operational aspects of orbital mechanics and space surveillance. Extensive computer programming including development, coding, testing, and analysis in c++, c#, FORTRAN, HTML, MATLAB, PASCAL, PERL, UNIX, VBA, VBS.

Security Clearance: Previously adjudicated for Top Secret/SCI SBI / SSBI Sep 21, 2002, update 2008.

EXPERIENCE

2020 – Date, Senior Research Astrodynamist, Commercial Space Operations Center. Developed new models and techniques for integration with Space Situational Awareness programs and operations.

Highlights: Integrated semianalytical methods and improved numerical techniques to state-of-the-art satellite analysis programs. Conducted research in space weather prediction approaches and the effect on satellite lifetime. Investigated new Uncorrelated Target processing approaches for use in space catalog development and operations.

2004 – 2020, Senior Research Astrodynamist, Analytical Graphics Inc. Developed new models and techniques for integration with Systems and Orbit Determination Toolkit software packages. Standardized approaches for analytical orbit propagation and data dissemination.

Highlights: Documented and distributed primary analytical propagation method (Simplified General Perturbations SGP4) for worldwide use. Conducted research in comparing legacy numerical integration programs including detailed force model analysis. Performed studies of propagation and prediction accuracies, and covariance realism. Conducted studies to implement the newest International Standard coordinate systems. Examined advanced orbit determination techniques to enhance conjunction operations and perform automated operational analysis.

2000 - 2003 **Principal Engineer, Raytheon, Denver CO**

Worked to integrate new technologies into ground software control systems. Led system acceptance testing for customer.



Vallado, D.A., Center for Space Standards and Innovation
27 May 2021

Highlights: Organized new and key technology for the program. Educated several organizations about the operations and data required to achieve mission success.

1998 - 2000 **Orbital Analyst**, US Space Command, Peterson AFB, CO

Leads and directs current and future astrodynamics operations for Space Command. Oversees and mediates development and integration of joint astrodynamics theories between the AF and the Navy. Led certification testing for laser clearinghouse operations on Tactical High Energy Laser.

Highlights: Formed Joint Astrodynamics Working Group to address Joint space surveillance issues. Documented first ever numerical values into formal (JROC) requirements process for space surveillance.

1996 - 1998 **Chief, Systems Engineering Division**, Air Force Research Lab, Kirtland AFB, NM

Responsible for elite engineering team for \$10M/year software effort for SECAF-directed, national priority program. Led, planned and directed mission planning development for first-of-a-kind operational system.

Highlights: Blueprinted the future overhaul of DoD Space Surveillance activities with a detailed technical plan for senior leaders.

1992 - 1996 **Deputy Chief, Astrodynamics Division**, Phillips Lab, Kirtland AFB, NM

Supervised the genesis of a new technical branch including the acquisition of technical experts. Led, formulated and directed efforts for integrating high accuracy laser measurements into precision satellite ephemerides, including the first ever non-sunlit laser illumination. Initiated development of next generation satellite propagation and differential correction routines essential for all technical operations of Space Command.

Highlights: Author of advanced astrodynamics textbook to integrate operational and theoretical techniques. Directed, assembled, and managed 25-person technical review team to complete final technical review.

1988 - 1992 **Assistant Professor, Department of Astronautics**, USAF Academy, CO, and **Adjunct Faculty, Department of Computer Science**, Colorado Technical College, CO



Developed several interactive graphics programs to aid the instruction of astrodynamics principles. Developed and taught the advanced astrodynamics courses at USAFA and directed the senior engineering design course. Also taught undergraduate courses in computer science due to extensive programming skills. Developed software documentation standards for several departments. Performed research for Phillips Laboratory at Kirtland AFB to develop an interactive, 3-dimensional graphics program for use in testing various orbital maneuvers. Conducted research projects with AFSPC and USSPACECOM examining astrodynamics, satellite ephemeris error predictions, and satellite intercept and evasive maneuvers.

Highlights: Engineering Company Grade Officer (CGO) of the quarter, #1 of 63 eligible. Department CGO of the year the first year of assignment. Published technical report (USAFA TR-91-6) containing over 14000 lines of PASCAL and FORTRAN code to solve various astrodynamics problems.

1984 - 1988 **Analysis Branch Chief**, 544th Strategic Intelligence Wing, Offutt AFB, NE

Supervised four engineers in analysis of foreign and US ICBMs and SLBMs. Initiated procedural agreements between SAC, FTD, NISC, and Space Command for supply of critical missile performance information to the warning systems. Re-derived Trajectory Analysis Program equations and relations, corrected errors and improved efficiency. Developed new capabilities and documented the mathematical techniques. Ensured continuity with successors.

Highlights: Derived, coded, tested, and briefed the follow-on algorithm for use in the SAC/NORAD/JCS warning systems (Command Center Processing Display System - Replacement). Operational use lasted over 12 years.

1980 - 1983 **Peacekeeper Stage I Project Officer**, Ballistic Missile Office, Norton AFB, CA

Managed the Full-Scale Engineering Development (FSED) Contract to build the Stage I motor. Coordinated acquisition, financial, contractual and technical management of the program. Obtained additional out-of-cycle funds from Congress to construct new facilities at a government owned plant.

Highlights: Provided technical assessment and guided negotiation of the Follow-on FSED Contract. Led Contractor/Air Force failure analysis teams to examine and correct component failures.

Relevant Air Force Training

Air Command and Staff College (Senior Executive Management Preparation), 1995

Systems Engineering Management Course, 1992

Software Engineering with Ada, 1991

Introduction to Acquisition Management (SYS100), 1989

Squadron Officers School (Executive Management Preparation), 1985

IBM Job Control Language and Utilities class, 1985

SUMMARY OF PERSONAL TECHNICAL ACCOMPLISHMENTS

1. Author of textbook Fundamentals of Astrodynamics and Applications, 1997, 2001, 2004, 2007, 2013. The standard university textbook for undergraduate and graduate astrodynamics curriculums
2. Developed new astrodynamics processes for integration into graphical visualization software.
3. Led, formulated, and directed efforts for integrating high accuracy laser measurements into precision satellite ephemerides, including the first ever non-sunlit laser illumination.
4. Created an interactive, 3-dimensional graphics program for use in testing various orbital maneuvers for Air Force Research Lab (AFRL)
5. Derived, coded, tested, and briefed the follow-on missile flight time algorithm for use in the Command Center Processing Display System Replacement.
6. Coordinated acquisition, financial, contractual and technical management of the MX Stage I missile program
7. Obtained out-of-cycle funds from Congress to construct new facilities at government owned plant. Anticipated and met simultaneous MX, Trident, and Shuttle processing schedules.

LEADERSHIP AND MANAGEMENT QUALIFICATIONS

1. Directed, assembled, and managed 25-person technical team to complete final review for astrodynamics textbook.
2. Documented first ever numerical values into formal (JROC) space surveillance requirements. All DoD space activities now have solid performance numbers for assessment.

3. Led certification testing for laser clearinghouse operations on Tactical High Energy Laser.
4. Formed and led Joint Astrodynamics Working Group to address military space surveillance issues. First ever progress to integrate Air Force and Navy technical systems.
5. Drafted DoD & Command policies and requirements for future Space Surveillance Network (SSN) architecture.
6. Responsible for elite engineering team for \$10M/year software effort for Secretary of the AF-directed, national priority program.
7. Masterfully accomplished genesis of new astrodynamics division for AF Space Laboratory.
8. Provided technical assessment and guided negotiation of the Follow-on MX missile contract.
9. Assembled contractor/Air Force failure analysis teams to examine and correct MX component failures.

PROFESSIONAL ASSOCIATIONS

American Astronautical Society (AAS), Fellow (2006)

American Institute of Aeronautics and Astronautics (AIAA), Associate Fellow

Former Member Astrodynamics Standards Committee (chair)

Former Associate Editor for Journal of Guidance, Control, and Dynamics

Associate Editor for Celestial Mechanics and Dynamical Astronomy Journal

HONORS AND AWARDS

Raytheon Distinguished Excellence in Technology, 2001

Who's Who in America, starting in 2001

Air Force Research & Development Award, 1998

Outstanding Young Men of America, 1998



MAJOR PUBLICATIONS

- Fundamentals of Astrodynamics and Applications**, 4th Edition Microcosm, 2013, 1106 pp.
- Systems Engineering Design, with Roland J. Bloom, Harper Collins Custom Books, 1993, 123 pp.
- Methods of Astrodynamics - A Computer Approach, USAFA TR 91-6, February, 1991

TEXTBOOK PUBLICATIONS

1. 2013. *Fundamentals of Astrodynamics and Applications*, 4th edition. Microcosm, Hawthorne CA. 1106 pgs.
2. 2010. *Orbital Mechanics Fundamentals*. Encyclopedia of Aerospace Engineering. Wiley Online Library.
3. 2007. *Fundamentals of Astrodynamics and Applications*, 3rd edition. Microcosm/Springer, Hawthorne CA. 1055 pgs.
4. 2006. *Modern Astrodynamics* (Chapter 1), 1st Edition, Elsevier Astrodynamics Series, Academic Press.
5. 2004. *Fundamentals of Astrodynamics and Applications*, 2nd edition, 2nd printing. Microcosm/Kluwer, El Segundo CA. 966 pgs.
6. 2001. *Fundamentals of Astrodynamics and Applications*, 2nd edition. Microcosm/Kluwer, El Segundo CA. 958 pgs.
7. 1997. *Fundamentals of Astrodynamics and Applications*. New York: McGraw-Hill. 922 pgs.
8. With Bloom, Roland J. 1993. *Systems Engineering Design*. Harper Collins. 123 pgs.

REFERRED JOURNAL ARTICLES

1. Vallado, David A., and Salvatore Alfano. 2014. Curvilinear Coordinate Transformation for Relative Motion. 118 (3):253-271, *Celestial Mechanics and Dynamical Astronomy*.
2. Vallado, David A., and David Finkleman. 2014. A Critical Assessment of Satellite Drag and Atmospheric Density Modeling. 95:141-165, *Acta Astronautica*.
3. Vallado, David A., and Scott S. Carter. 1999. Accurate Orbit Determination from Short-Arc Dense Observational Data. *Journal of the Astronautical Sciences*. 46 (2): 195–213.
4. Neta, Beny, and Vallado, David A. 1998. On Satellite Umbra/Penumbra Entry and Exit Positions. *Journal of the Astronautical Sciences*. 46 (1): 91–103.

CONFERENCE AND MISCELLANEOUS PAPERS

1. Vallado, David A., and Daniel L. Oltrogge. 2021. Satellite Lifetime and Solar Cycle Predictions. Poster presented at the 8th European Conference on Space Debris, April 20-23. Darmstadt, Germany.

2. Vallado, David A. 2019. Long-Term Numerical Propagation for Earth Orbiting Satellites. Paper AAS 19-601 presented at the AAS/AIAA Astrodynamics Specialist Conference, August 11-15. Portland, ME.
3. Vallado, David A., and James Woodburn and Tom Johnson. 2018. Sequential Processing of ILRS Observations – Experiences over the last 5 years. Paper IWLR 18-7.65 presented at the 21st International Workshop on Laser Ranging conference. Canberra, Australia, November 5-9.
4. Vallado, David A. 2018. Generating Realistic Sensor Observations for OD Analysis. Paper AAS 18-202 presented at the AAS/AIAA Astrodynamics Specialist Conference, August 19-23. Snowbird, UT.
5. Oltrogge Daniel L. and David A. Vallado. 2017. Application of new Debris Risk Evolution and Dispersal (DREAD) tool to characterize post-fragmentation risk. Paper AAS-17-600 presented at the AAS/AIAA Astrodynamics Specialist Conference, August 20-24. Columbia River Gorge, WA.
6. Vallado, David A., and Daniel L. Oltrogge. 2017. Fragmentation Event Debris Field Evolution using 3D Volumetric Risk Assessment. Paper presented at the 7th European Conference on Space Debris, April 18-21. Darmstadt, Germany.
7. Vallado, David A. et al. 2016. Orbital Strategies to Mitigate the Solar Exclusion Effect on Space-Based Observation of the Geosynchronous Belt. Paper AIAA-2016-5433 presented at the AIAA/AAS Astrodynamics Specialist Conference, Long Beach, CA, September 13-16, 2016.
8. Vallado, David A. and T.S. Kelso. 2015. New Consolidated Files for Earth Orientation Parameters and Space Weather Data. Paper AAS-15-500 presented at the AAS/AIAA Astrodynamics Specialist Conference, August 9-13. Vail, CO.
9. Vallado, David A. and Salvatore Alfano. 2015. Updated Analytical Partial for Covariance Transformations and Optimization. Paper AAS-15-237 presented at the AAS/AIAA Astrodynamics Specialist Conference, August 9-13. Vail, CO.
10. Vallado, David A., James Woodburn, and Florent Deleflie. 2014. Sequential Orbit Determination Using Satellite Laser Ranging. Paper AAS 14-287 presented at the AAS/AIAA Space Flight Mechanics Conference, January 26-30. Santa Fe, NM.
11. Vallado, David A., Benjamin Bastida Virgili, and Tim Flohrer. 2013. Improved SSA through Orbit Determination of Two-Line Element Sets. Paper 13-4a.O-7 presented at the 6th European Conference on Space Debris, April 22-25. Darmstadt, Germany.
12. Vallado, David A., and T.S. Kelso. 2013. Earth Orientation Parameter and Space Weather Data for Flight Operations. Paper AAS 13-373 presented at the AAS/AIAA Space Flight Mechanics Conference, February 10-14. Kauai, HI.
13. Vallado, David A., and Paul Cefola. 2012. Two-Line Element Sets – Practice and Use. Paper IAC-12.C1.6.12 presented at the 63rd International Astronautical Congress. October 1-5, 2012. Naples, Italy.
14. Vallado, David A., Thomas Kelecy and Moriba K. Jah. 2012. Data Integrity in Orbital Data Fusion. Paper IAC-12.A6.6.11 presented at the 63rd International Astronautical Congress. October 1-5, 2012. Naples, Italy.

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15. Vallado, David A. and Salvatore Alfano. 2011. Curvilinear Coordinates for Covariance and Relative Motion Operations. Paper AAS 11-464 presented at the AAS/AIAA Astrodynamics Specialist Conference. July 31-August 4, Girdwood, AK.
16. Vallado, David A. 2011. Verifying Observational Data for Real World Space Situational Awareness. Paper AAS 11-439 presented at the AAS/AIAA Astrodynamics Specialist Conference. July 31-August 4, Girdwood, AK.
17. Vallado, David A. and Jacob D. Griesbach. 2011. Simulating Space Surveillance Networks. Paper AAS 11-580 presented at the AAS/AIAA Astrodynamics Specialist Conference. July 31-August 4, Girdwood, AK.
18. Bradley, Ben K., and David A. Vallado, Aurore Sibois, and Penina Axelrad. 2011. Earth Orientation Parameter Considerations for Precise Spacecraft operations. Paper AAS 11-529 presented at the AAS/AIAA Astrodynamics Specialist Conference. July 31-August 4, Girdwood, AK.
19. Seago, John H., Jacob Griesbach, James W. Woodburn, and David A. Vallado. 2011. Sequential Orbit Estimation with Sparse Tracking. Paper AAS 11-123 presented at the AAS/AIAA Space Flight Mechanics Conference, February 17-20. New Orleans, LA.
20. Vallado, David A. and Vladimir Agapov. 2010. Orbit Determination Results from Optical Measurements. Paper AIAA-10-7525 presented at the AAS/AIAA Astrodynamics Specialist Conference, August 2-5. Toronto, Canada.
21. Lam, Quang M., and Daniel Junker, David Anhalt, and David A. Vallado. 2010. Analysis of an Extended Kalman Filter Based Orbit Determination System. Paper AIAA-10-7600 presented at the AAS/AIAA Astrodynamics Specialist Conference, August 2-5. Toronto, Canada.
22. Vallado, David A. 2010. Evaluating Gooding Angles-only Orbit Determination of Space Based Space Surveillance measurements. Paper AAS 10- presented at the Born Symposium, May 11-14. Boulder, CO.
23. Vallado, David A. and Vladimir Agapov. 2010. Orbit Determination Results from Optical Measurements. Paper 10A08-1866000 presented at the 4th International Conference on Astrodynamics Tools and Techniques (ICATT) Conference, May 3-6. Madrid, Spain.
24. Vallado, David A., et al. 2010. Orbit Determination Using ODTK Version 6. Paper 10A08-1855538 presented at the 4th International Conference on Astrodynamics Tools and Techniques (ICATT) Conference, May 3-6. Madrid, Spain.
25. Vallado, David A. 2010. Evaluating Gooding Angles-only Orbit Determination of Space Based Space Surveillance measurements. Paper USR 10-S4.5 presented at the US/Russian Workshop, April 18-23. Maui, HI.
26. Seago, John H. and David A Vallado. 2010. Goodness of Fit Test for Orbit Determination. Paper AAS 10-149 presented at the AAS/AIAA Space Flight Mechanics Conference, February 14-17. San Diego, CA.
27. Vallado, David A. and John H. Seago. 2009. Covariance Realism. Paper AAS 09-304 presented at the AAS/AIAA Astrodynamics Specialist Conference, August 9-13. Pittsburgh, PA.
28. Vallado, David A., T.S. Kelso, Vladimir Agapov, and Igor Molotov. 2009. Orbit Determination Issues and Results to incorporate Optical Measurements in Conjunction Operations. Paper presented at the 5th European Conference on Space Debris, March 30-April 2. Darmstadt, Germany.

29. Coppola, Vincent, John H. Seago, and David A. Vallado. 2009. The IAU 2000A and IAU 2006 Precession-Nutation Theories and their Implementation. Paper AAS 09-159 presented at the AAS/AIAA Space Flight Mechanics Conference, February 9-12. Savannah, GA.
30. Vallado, David A., and David Finkleman. 2008. A Critical Assessment of Satellite Drag and Atmospheric Density Modeling. Paper AGI-UTH-Vallado presented at the AGI Users Conference, October 7-9. Chicago, IL.
31. Vallado, David A., and David Finkleman. 2008. A Critical Assessment of Satellite Drag and Atmospheric Density Modeling. Paper AIAA 2008-6442 presented at the AAS/AIAA Astrodynamics Specialist Conference, August 18-21. Honolulu, HI.
32. Vallado, David A., and Paul Crawford. 2008. SGP4 Orbit Determination. Paper AIAA 2008-6770 presented at the AAS/AIAA Astrodynamics Specialist Conference, August 18-21. Honolulu, HI.
33. Vallado, David A. 2007. An Analysis of State Vector Prediction Accuracy. Paper USR 07-S6.1 presented at the US/Russian Workshop, October 29-November 2. Monterey, CA.
34. Vallado, David A. 2007. A Preliminary Analysis of State Vector Prediction Accuracy. Paper AAS 07-358 presented at the AAS/AIAA Astrodynamics Specialist Conference, August 19-23. Mackinac, MI.
35. Vallado, David A., Paul Crawford, Richard Hujsak, and T.S. Kelso. 2006. Revisiting SpaceTrack Report #3. Paper AIAA 2006-6753 presented at the AIAA/AAS Astrodynamics Specialist Conference, August 21-24. Keystone CO.
36. Vallado, David A., John H. Seago, and P. Kenneth Seidelmann. 2006. Implementation Issues Surrounding the New IAU Reference Systems for Astrodynamics. Paper AAS 06-134 presented at the AAS/AIAA Space Flight Mechanics Conference, January 22-26. Tampa, FL.
37. Vallado, David A., and T. S. Kelso. 2005. Using EOP and Solar Weather Data for Real-time Operations. Paper USR 05-S7.3 presented at the US/Russian Space Surveillance Workshop, August 22-26. St Petersburg, Russia.
38. Vallado, David A., and T. S. Kelso. 2005. Using EOP and Solar Weather Data for Real-time Operations. Paper AAS 05-406 presented at the AAS/AIAA Astrodynamics Specialist Conference, August 7-11. Lake Tahoe, CA.
39. Vallado, David A. 2005. An Analysis of State Vector Propagation for Differing Flight Dynamics Programs. Paper AAS 05-199 presented at the AAS/AIAA Space Flight Mechanics Conference, January 23-27. Copper Mountain, CO.
40. Vallado, David A. 2003. Covariance Transformations for Satellite Flight Dynamics Operations. Paper AAS 03-526 presented at the AAS/AIAA Astrodynamics Specialist Conference, August 4-7. Big Sky, MT.
41. Vallado, David A. 2001. A Summary of the AIAA Astrodynamics Standards Effort. Paper AAS 01-429 presented at the AIAA/AAS Astrodynamics Specialist Conference, July 30-August 2. Quebec City, Canada.
42. Seago, John and David Vallado. 2000. Coordinate Frames of the U.S. Space Object Catalogs. Paper AIAA 2000-4025 presented at the AIAA/AAS Astrodynamics Specialist Conference, August 14-17. Denver CO.

43. Sabol, Chris, and Scott Carter, David Vallado. 1999. A Fresh Look at Angles-only Orbit Determination. Paper AAS 99-363 presented at the AIAA/AAS Astrodynamics Specialist Conference, August 16-19. Girdwood, AK.
44. Vallado, David A. 1999. Software for Astrodynamics. Paper AAS 99-157 presented at the AAS/AIAA Space Flight Mechanics Conference, February 7-10. Breckenridge, CO.
45. Vallado, David A., and Salvatore Alfano. 1999. A Future Look at Space Surveillance and Operations. Paper AAS 99-113 presented at the AAS/AIAA Space Flight Mechanics Conference, February 7-10. Breckenridge, CO.
46. Vallado, David A. 1998. An Analysis of the Behavior of the J2000 Reduction Matrices. Paper AAS 98-155 presented at the AAS/AIAA Astrodynamics Specialist Conference, February 9-11. Monterey, CA.
47. Vallado, David A., and Salvatore Alfano. 1998. A Future Look at Space Surveillance and Operations. Paper presented at the US/Russia Workshop, October 20-23. US Naval Observatory, DC.
48. Moore, Gilbert, and Scott Heritsch, Skip Dopp, David Vallado, Lee Abraham, Mehrdad Roosta. 1997. Paper SSC 97-V-6 presented at the 11th AIAA/USU Conference on Small Satellites.
49. Vallado, David A., and Scott S. Carter. 1997. Accurate Orbit Determination from Short-Arc Dense Observational Data. Paper AAS 97-704 presented at the AAS/AIAA Astrodynamics Specialist Conference, August 4-7. Sun Valley, ID.
50. Vallado, David A. 1993a. A Study in Relative Motion. Phillips Laboratory, Kirtland AFB, NM.
51. Vallado, David A. 1993b. A Study in Intercept and Rendezvous Techniques. Phillips Laboratory, Kirtland AFB, NM.
52. Vallado, David A. 1992a. Statistical Orbit Determination. USAFA/DFAS A422 Course Reading. U.S. Air Force Academy, CO.
53. Vallado, David A. 1992b. Methods of Astrodynamics—A Computer Approach. USAFA/DFAS. Version 4.0. 14 Mar 92. (Ver 3.0 was USAFA TR 91-6).. U.S. Air Force Academy, CO.
54. Vallado, David A. 1992c. Software Standard, *PASCAL and FORTRAN*, . U.S. Air Force Academy, CO.
55. Vallado, David A. 1991. Orbital Phasing. USAFA/DFAS A321 course reading. U.S. Air Force Academy, CO.
56. Vallado, David A. 1991a. Reconnaissance Mission Planning. USAFA/DFAS A422 course reading. U.S. Air Force Academy, CO.
57. Vallado, David A. 1990. Orbital Maneuvering. USAFA/DFAS. A321 Course Text, US Air Force Academy, CO.
58. Vallado, David A., and John M. Hanson. 1989. Satellite Ephemeris Error Modeling (SEEM) Implementation on Government Microcomputers. USSPACECOM/AN Technical Note, CAA-TN-89-010. Colorado Springs, CO.
59. Roerich, Ronald, and David A. Vallado. 1988. Potential debris pattern resulting from vehicle destruction while in a boost phase. USSPACECOM/AN Tech Note, CAA-TN-88-003, Colorado Springs, CO.